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(21)Application number : 2000-136695 (71)Applicant : NKK CORP

(22)Date of filing : 10.05.2000 (72)Inventor : MIYAMOTO HIDEYUKI  
TAKASU NOBUO

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(54) MATERIAL DISCRIMINATION DEVICE FOR WASTE PLASTIC

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a material discrimination device for waste plastic capable of minimizing reduction of a reflectance of a reflection near-infrared spectrometer, and maintaining material discrimination precision high.

SOLUTION: This material discrimination device for the waste plastic is equipped with a light source for radiating light containing a near infrared ray, and a facing reflector across the waste plastic for discriminating the material thereof, arranged roughly perpendicularly with the optical axis of the light source, a spectrometer for executing spectrometry of the near infrared ray radiated from the light source and reflected by the waste plastic or the reflector, and an operation device for determining the material of the waste plastic based on the result of the spectrometry by the spectrometer. The device has a formation having irregularities formed on the reflecting surface of the reflector.

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**CLAIMS**  
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[Claim(s)]

[Claim 1] The reflecting plate which countered the waste plastic for being arranged at the optical axis and abbreviation right angle of the light source which emits the light containing a near infrared ray, and this light source, and identifying the quality of the material by \*\*\*\*, The spectroscopy which carries out the spectrometry of the near infrared ray which was emitted from said light source and reflected with the waste plastic or the reflecting plate, the spectrum of this spectroscopy -- the quality-of-the-material identification unit of the waste plastic characterized by preparing irregularity in the reflector of said reflecting plate in the quality-of-the-material identification unit of waste plus CHI@KKU equipped with the arithmetic unit which determines the quality of the material of said waste plastic based on a result.

[Claim 2] The quality-of-the-material identification unit of the waste plastic according to claim 1 characterized by forming the cross-section configuration of the irregularity of this reflector in the shape of a triangular wave when said reflector is a diffuse reflection object.

[Claim 3] The quality-of-the-material identification unit of the waste plastic according

to claim 1 characterized by forming the cross-section configuration of the irregularity of this reflector in the shape of [ concave ] a radii wave when said reflector is a diffuse reflection object.

[Claim 4] The quality-of-the-material identification unit of the waste plastic according to claim 1 characterized by forming the cross-section configuration of the irregularity of this reflector in the shape of a square wave when said reflector is a specular reflector or a diffuse reflection object.

[Claim 5] The quality-of-the-material identification unit of the waste plastic according to claim 4 characterized by setting the area for heights of said reflector to less than 50% of the total surface area.

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the quality-of-the-material identification unit of the waste plastic for identifying the quality of the material of disposal plastics (the following, waste plastic) like the PET bottle mixed in dust in a waste disposal and treatment facility etc.

[0002]

[Description of the Prior Art] Two measurement modes are mainly known by reflective mold near infrared ray spectroscopy. One of them is in diffuse reflection mode by the diffuse reflection accompanying own dispersion of a sample, and it is in transparency reflective mode measured after the irradiated near infrared ray is reflected by the reflecting plate of a sample in back in the case of other samples with transparent one and penetrating a sample again. There is a diffuse reflection object which carries out diffuse reflection to the specular reflector which carries out full reflection like a metal as a reflecting plate used in transparency reflective mode like a ceramic. for example, Koyo Ozaki work "NIR spectroscopy" -- if transparency and dispersion of the near infrared ray in both the modes are explained to the 88-90th page and the outline of the principle Fig. is shown, it will be as drawing 5 .

[0003] In drawing 5 , Sp is [ a near infrared ray and Re of a spectroscope and Nu ] reflecting plates. A reflecting plate Re consists of specular reflectors at drawing 5 (a), and it is constituted from (b) by the diffuse reflection object. In this case, even if it is in the condition of there being no dirt in the sample which it is going to measure, and having contacted the sample to the above-mentioned reflecting plate when pure, the reflective near infrared ray which reflected the property of a sample correctly can be measured. This can be measured not only a solid-state like plastics but where the liquid

which can apply also about a liquid and is measured is poured in the condition of having accumulated in the cel etc. directly in the front face of a reflecting plate, or a pipe.

[0004] Drawing 6 is the explanatory view showing the configuration of this kind of conventional equipment, and it is the elevation in which (a) shows a side elevation and (b) shows the dirt condition of a reflecting plate. In drawing 6, Be is a band conveyor and Sa is a sample. Moreover, the dirt part into which Du became dirty from adhesion of dust etc., and Ar are the discernment fields of the quality of the material. It is soiled within trash like the above-mentioned waste plastic, and Sample Sa is sorted out from dust as it is. And while the sample Sa on Belt Be contacts a reflecting plate Re, for example, it is conveyed by the near side from the front, it is projected on a near infrared ray with Spectroscope Sp on the way, and the quality of the material of Sample Sa is discriminated from the measurement result of the reflected light.

[0005]

[Problem(s) to be Solved by the Invention] In the conventional identification unit by which it was \*\* carried out to drawing 6, as mentioned above, while Sample Sa approaches or contacts a reflecting plate Re, it is conveyed, and the quality of the material is identified using the reflected light when passing through Spectroscope Sp front. Therefore, the dirt of the sample Sa under conveyance is moved to a reflecting plate Re side, dust adheres to the reflector of a reflecting plate Re, and a reflection factor is made to fall to it remarkably. As the dirt condition of the reflecting plate Re at this time was shown in drawing (b), corresponding to passage of Sample Sa, continuous dirt is formed in the conveyance direction with constant width on an even reflector. For this reason, when the time of the dirt part Du occupying most discernment fields Ar, for example, there being no sample Sa is made into the reference value of measurement, a reference value will be changed with dirt and dispersion will arise in the reflected light. Consequently, there was a trouble that the quality-of-the-material discernment precision of Sample Sa fell extremely.

[0006] It was accomplished in order that this invention might cancel the trouble of equipment conventionally [ above ], and it aims at realizing the quality-of-the-material identification unit of a waste plastic with a high discernment precision, without being influenced by dirt even when measuring many samples of the unclean waste plastic continuously.

[0007]

[Means for Solving the Problem] The reflecting plate which countered the waste plastic for this invention being arranged at the optical axis and abbreviation right angle of the light source which emits the light containing a near infrared ray, and the light source, and identifying the quality of the material by \*\*\*\*, In the quality-of-the-material identification unit of waste plus CHI@KKU equipped with the arithmetic unit which determines the quality of the material of a waste plastic based on a result the spectrum of the spectroscope which carries out the spectrometry of the near infrared ray which

was emitted from the light source and reflected with the waste plastic or the reflecting plate, and a spectroscopy -- The quality-of-the-material identification unit of the waste plastic which prepared irregularity in the reflector of a reflecting plate is constituted. Moreover, in the above, when a reflector is a diffuse reflection object, the quality-of-the-material identification unit of the waste plastic which formed the cross-section configuration of the irregularity of a reflector in the shape of a triangular wave is constituted. Moreover, in the above, when a reflector is a diffuse reflection object, the quality-of-the-material identification unit of the waste plastic which formed the cross-section configuration of the irregularity of a reflector in the shape of [ concave ] a radii wave is constituted. Moreover, in the above, when a reflector is a specular reflector, the quality-of-the-material identification unit of the waste plastic which formed the cross-section configuration of the irregularity of a reflector in the shape of a square wave is constituted. Furthermore, in the above, the quality-of-the-material identification unit of the waste plastic which set the area for heights of a reflector to less than 50% of the total surface area is constituted.

[0008]

[Embodiment of the Invention] The top view in which gestalt 1. drawing 1 of operation shows the configuration of the gestalt 1 of operation of this invention, and drawing 2 are the sectional view Fig. of the reflecting plate in drawing 1 , and the elevation showing the dirt condition of the reflecting plate of the gestalt 1 of operation. Here, the case where the quality of the material of the plastics bottle sorted out out of trash in the gestalt 1 of operation of this invention is applied to the equipment identified continuously is illustrated. In drawing 1 thru/or drawing 3 , a band conveyor, 21, and 22 -- of 1 are many plastics bottles. 3 is the identification unit formed in the discernment circles of a conveyor line, and is for identifying the quality of the material of a waste plastic. A plastics bottle 21 and 22 -- are conveyed one after another in the direction of an arrow head of void on a band conveyor 1.

[0009] It is the reflecting plate which 4 was prepared near the inlet port in an identification unit 3, a plastics bottle 21, the bottle sensor of 22 -- which detects existence, and 5 sandwiched the reflective mold near infrared ray spectroscopy, and 6 sandwiched the band conveyor 1, and countered the reflective mold spectroscopy 5. Moreover, the irregularity by which 7 was formed in the reflector of a reflecting plate 6 at the pinstriped pattern, and 71 and 72 are the heights and the crevices of irregularity 7 (generic name). The light source containing a near infrared ray 50 is built in the reflective mold spectroscopy 5, and the incident light is projected on a reflecting plate 6 through the plastics bottle 21 of the top face of a band conveyor 1, and the optical axis of the direction of 22 -- which intersects a conveyance path. Moreover, the reflector of a reflecting plate 6 is the specular reflector which was mentioned above and which carries out full reflection, and it is \*\* carried out of the cross section to drawing 2 .

[0010] Like illustration, since the irregularity 7 formed in the reflecting plate 6 makes

the full reflection of the incident light carry out in the direction of a right angle, it is formed in the square and rectangle in which an inclined plane does not have a cross-section configuration by it so that a reflector may counter in an optical axis and the direction of a right angle. Especially, in this invention, it is formed in the shape of [ the heights 71 of narrow width of face and the crevice 72 of large width of face were made to follow ] a square wave so that the surface ratio of heights 71 may become remarkably small to a total reflection side. And it is reflected by the reflecting plate 6, and the near infrared ray 50 on which it was projected from the reflective mold spectroscopy 5 follows the optical path of the reverse sense to which the reflected light meets an incident light shaft, and it carries out incidence to a spectroscopy 5.

[0011] The upstream of the discernment section which installed the identification unit 3 along Rhine of a band conveyor 1 is the alignment section for aligning the plastics bottle 21 and 22 -- which were sorted out from trash on a band conveyor 1. Moreover, the identified plastics bottle 21 and the judgment section which classifies 22 -- according to the quality of the material are prepared in the downstream from the discernment section. in addition, although not illustrated, the encoder which detects passing speed installs in the drive of a band conveyor 1 -- having -- the spectrum of the reflective mold spectroscopy 5 -- the control unit which has the calculation function which calculates the quality of the material from a result, or controls measurement actuation etc. is formed.

[0012] Actuation of the gestalt 1 of the operation constituted as mentioned above is explained below. The plastics bottle 21 of a large number sorted out from trash and 22 -- align in the alignment section preceded on Rhine, and are conveyed by the sequential discernment section on a band conveyor 1. The existence is detected by the bottle sensor 4 by which each plastics bottle 21 conveyed by the discernment section and 22 -- were first prepared in the inlet port. The bottle sensor's 4 detection of each plastics bottle 21 and 22 -- starts count actuation of the aforementioned encoder based on a detection signal. And an actuating signal is outputted from a control device by the output signal of an encoder, and they are each plastics bottles 21 and 22 under conveyance. -- Measurement actuation of the reflective mold spectroscopy 5 is performed for every hitting time.

[0013] By the control device, if the hitting time when the corresponding plastics bottle 21 was computed comes, according to this time of day, discernment actuation of the quality of the material of the plastics bottle 21 by the reflective mold spectroscopy 5 will be started. It is projected on a near infrared ray 50 by the reflecting plate 6 from the reflective mold spectroscopy 5 by initiation of discernment actuation, and the reflected light carries out incidence to the reflective mold spectroscopy 5. At this time, the incident light and the reflected light of a near infrared ray 50 penetrate the plastics bottle 21 conveyed while contacting a reflecting plate 6 on a band conveyor 1 like conventional equipment. And it is compared with the background wave into which the

part optical output of the reflective mold spectroscopy 5 was beforehand registered in the measurement process, and the quality of the material of a plastics bottle 21 is identified.

[0014] However, with the gestalt 1 of operation of this invention, the irregularity 7 of the shape of a square wave which formed the heights 71 of narrow width of face is formed in the reflector of a reflecting plate 6 as mentioned above. Therefore, the plastics bottle 21 conveyed one after another in the reflector of a reflecting plate 6 and the part soiled by contacting 22 -- will be restricted to the heights 71 which have a slight area of the square wave-like irregularity 7. That is, most near infrared rays 50 on which it was projected from the reflective mold spectroscopy 5 are reflected by the crevice 72 of the irregularity 7 which is not soiled by occupying a large area to the total reflection side. Therefore, as compared with equipment, a dirt part becomes discontinuity conventionally using the reflecting plate of a flat reflector, and it is \*\* carried out of the dirt condition of the reflector of the reflecting plate 6 at this time to drawing 3 .

[0015] 11 and 12 of drawing 3 are a dirt part and a discernment field, and it corresponds to Du and Ar of drawing 6 (b). \*\* from drawing 3 -- as if -- the area occupied in the discernment field 12 of the dirt part 11 becomes very small, does not fall a reflection factor, and hardly influences discernment of the quality of the material. When it follows, for example, surface ratio of heights 71 and a crevice 72 is set to 1:9, even if the reflection factor of heights 71 becomes 0% by dirt on the basis of the original reflection factor, as the whole reflecting plate 6, it can stop to 90% of fall. the spectrum of the reflective mold spectroscopy 5 for such a discernment field 12 -- the quality of the material of a plastics bottle 21 and 22 -- is identified by the arithmetic unit which is not illustrated using a result. According to a discernment result, it will let out the plastics bottle 21 and 22 -- which were identified to the judgment section of the downstream one by one, and they will be classified according to the quality of the material.

[0016] The diffuse reflection object which reflects gestalt 2 drawing 4 of operation in the direction to the reflecting plate 6 of the gestalt 2 of this operation where are the explanatory view showing the configuration of the important section of the gestalt 2 of operation of this invention, and reflected lights are various, and are scattered about is used. At drawing 4 (a), the irregularity 7 of the shape of the shape of a semicircle of a concave [ configuration / cross-section ] and radii is formed in the reflector of a reflecting plate 6 for the irregularity 7 of a reflector by the shape of a triangular wave at (b). Moreover, the irregularity 7 of a square drill and a cylindrical shape is formed in drawing (c) and (d). Since there is no angular relation-ship of the light source side which is countered in the case of diffuse reflection, and a reflecting plate 6 severely like a specular reflector, irregularity 7 can be set up freely. As explained above in any [ of a specular reflector and a diffuse reflection object ] case, only heights 71 will be limited and the dirt part 11 of a reflector can suppress decline in the reflection factor of a reflecting plate 6 to the minimum.

[0017] In addition, although the case where a cross section formed the irregularity of a pinstriped square wave-like mold was illustrated and explained with the gestalt of above-mentioned operation when a specular reflector was used for a reflecting plate, irregularity, such as slanting stripes and a disk, may be formed. Moreover, although the irregularity of the shape of a triangular wave and semicircle wavelike \*\* was shown in the drawing when a diffuse reflection object was used for a reflecting plate, a \*\*\*\* form and a cross section can also constitute multiple spindles, such as a trapezoid, or these combination. Moreover, although the case where measured a waste plastic continuously and it was identified in a waste disposal and treatment facility was illustrated with the gestalt of operation, it does not necessarily limit batch measurement being sufficient, and installing a bottle sensor in a reflecting plate etc. and omitting an encoder etc. to the gestalt of operation.

[0018]

[Effect of the Invention] The reflecting plate which countered the waste plastic for this invention being arranged at the optical axis and abbreviation right angle of the light source which emits the light containing a near infrared ray, and the light source, and identifying the quality of the material by \*\*\*\*, In the quality-of-the-material identification unit of waste plus CHI@KKU equipped with the arithmetic unit which determines the quality of the material of a waste plastic based on a result the spectrum of the spectroscopy which carries out the spectrometry of the near infrared ray which was emitted from the light source and reflected with the waste plastic or the reflecting plate, and a spectroscopy -- The quality-of-the-material identification unit of the waste plastic which prepared irregularity in the reflector of a reflecting plate was constituted. Moreover, in the above, when a reflector was a diffuse reflection object, the quality-of-the-material identification unit of the waste plastic which formed the cross-section configuration of the irregularity of a reflector in the shape of a triangular wave was constituted. Moreover, in the above, when a reflector was a diffuse reflection object, the quality-of-the-material identification unit of the waste plastic which formed the cross-section configuration of the irregularity of a reflector in the shape of [concave] a radii wave was constituted. Moreover, in the above, when a reflector was a specular reflector, the quality-of-the-material identification unit of the waste plastic which formed the cross-section configuration of the irregularity of a reflector in the shape of a square wave was constituted. Furthermore, in the above, the quality-of-the-material identification unit of the waste plastic which set the area for heights of a reflector to less than 50% of the total surface area was constituted.

[0019] In the equipment which identifies the quality of the material of a waste plastic as mentioned above, the reflecting plate was polluted with the dirt adhering to a waste plastic, and this invention constituted the quality-of-the-material identification unit of the waste plastic to which form irregularity in a front face and a dirt part is made to limit. Consequently, decline in the reflection factor of a reflective mold near infrared ray



spectroscope can be made into the minimum, and quality-of-the-material discernment precision can be maintained highly.

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## DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] It is the top view showing the configuration of the gestalt 1 of operation of this invention.

[Drawing 2] It is the sectional view of the reflecting plate in drawing 1 .

[Drawing 3] It is the elevation showing the dirt condition of the reflecting plate of the gestalt 1 of operation.

[Drawing 4] It is the explanatory view showing the configuration of the gestalt 2 of operation of this invention.

[Drawing 5] It is the drawing in which the configuration in the measurement mode for explaining this invention is shown.

[Drawing 6] It is the explanatory view showing the configuration and actuation of equipment conventionally.

[Description of Notations]

1 Band Conveyor

21, 22 -- Plastics bottle

3 Identification Unit

4 Bottle Sensor

5 Reflective Mold Spectroscope

6 Reflecting Plate

7 Irregularity

50 Near Infrared Ray

71 Heights

72 Crevice